U. S. DEPARTMENT OF AGRICULTURE.

FARMERS' BULLETIN No. 267.

# Experiment Station Work,

## XXXVII.

Compiled from the Publications of the Agricultural Experiment Stations.

BREEDING CORN.
BUCKWHEAT.
SUGAR BEETS ON ALKALI SOILS.
ALFILARIA AS A FORAGE PLANT.
APPLE BITTER ROT.
GRASS MULCH FOR ORCHARDS.
HARDINESS OF YOUNG FRUIT TREES.
PROTECTING COWS FROM FLIES.
EFFECT OF SILAGE ON MILK.
COLD STORAGE OF CHEESE.

PREPARED IN THE OFFICE OF EXPERIMENT STATIONS.

A. C. TRUE, Director.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1906.

# THE AGRICULTURAL EXPERIMENT STATIONS.

ALABAMA—
College Station: *Auburn;* J. F. Duggar.[a]
Canebrake Station: *Uniontown;* J. M. Richeson.[b]
Tuskegee Station: *Tuskegee;* G. W. Carver.[a]

ALASKA—*Sitka:* C. C. Georgeson.[c]

ARIZONA—*Tucson:* R. H. Forbes.[a]

ARKANSAS—*Fayetteville:* W. G. Vincenheller.[a]

CALIFORNIA—*Berkeley:* E. J. Wickson.[d]

COLORADO—*Fort Collins:* L. G. Carpenter.[a]

CONNECTICUT—
State Station: *New Haven;* E. H. Jenkins.[a]
Storrs Station: *Storrs;* L. A. Clinton.[a]

DELAWARE—*Newark:* Harry Hayward.[a]

FLORIDA—*Lake City:* P. H. Rolfs.[a]

GEORGIA—*Experiment:* R. J. Redding.[a]

HAWAII—
Federal Station: *Honolulu;* J. G. Smith.[c]
Sugar Planters' Station: *Honolulu;* C. F. Eckart.[a]

IDAHO—*Moscow:* H. T. French.[a]

ILLINOIS—*Urbana:* E. Davenport.[a]

INDIANA—*Lafayette:* A. Goss.[a]

IOWA—*Ames:* C. F. Curtiss.[a]

KANSAS—*Manhattan:* C. H. Burkett.[a]

KENTUCKY—*Lexington:* M. A. Scovell.[a]

LOUISIANA—
State Station: *Baton Rouge.*
Sugar Station: *Audubon Park, New Orleans.*
North Louisiana Station: *Calhoun;* W. R. Dodson (*Baton Rouge*).[a]

MAINE—*Orono:* C. D. Woods.[a]

MARYLAND—*College Park:* H. J. Patterson.[a]

MASSACHUSETTS—*Amherst:* W. P Brooks.[a]

MICHIGAN—*Agricultural College:* C. D. Smith.[a]

MINNESOTA—*St. Anthony Park, St. Paul:* W. M. Liggett.[a]

MISSISSIPPI—*Agricultural College:* W. L. Hutchinson.[a]

MISSOURI—
College Station: *Columbia;* H. J. Waters.[a]
Fruit Station: *Mountain Grove;* P. Evans.[a]

MONTANA—*Bozeman:* F. B. Linfield.[a]

NEBRASKA—*Lincoln:* E. A. Burnett.[a]

NEVADA—*Reno:* J. E. Stubbs.[a]

NEW HAMPSHIRE—*Durham:* W. D. Gibbs.[a]

NEW JERSEY—*New Brunswick:* E. B. Voorhees.[a]

NEW MEXICO—*Agricultural College:* L. Foster.[a]

NEW YORK—
State Station: *Geneva;* W. H. Jordan.[a]
Cornell Station: *Ithaca;* L. H. Bailey.[a]

NORTH CAROLINA—*Raleigh:* B. W. Kilgore.[a]

NORTH DAKOTA—*Agricultural College:* J. H. Worst.[a]

OHIO—*Wooster:* C. E. Thorne.[a]

OKLAHOMA—*Stillwater:* W. L. English.[a]

OREGON—*Corvallis:* J. Withycombe.[a]

PENNSYLVANIA—*State College:* H. P. Armsby.[a]

PORTO RICO—*Mayaguez:* D. W. May.[c]

RHODE ISLAND—*Kingston:* H. J. Wheeler.[a]

SOUTH CAROLINA—*Clemson College:* J. N. Harper.[a]

SOUTH DAKOTA—*Brookings:* J. W. Wilson.[a]

TENNESSEE—*Knoxville:* H. A. Morgan.[a]

TEXAS—*College Station:* John A. Craig.[a]

UTAH—*Logan:* P. A. Yoder.[a]

VERMONT—*Burlington:* J. L. Hills.[a]

VIRGINIA—*Blacksburg:* A. M. Soule.[a]

WASHINGTON—*Pullman:* E. A. Bryan.[a]

WEST VIRGINIA—*Morgantown:* J. H. Stewart.[a]

WISCONSIN—*Madison:* W. A. Henry.[a]

WYOMING—*Laramie:* B. C. Buffum.[a]

[a] Director. [b] Assistant director. [c] Special agent in charge. [d] Acting director.

267

# EXPERIMENT STATION WORK.

Edited by W. H. BEAL and the Staff of the Experiment Station Record.

Experiment Station Work is a subseries of brief popular bulletins compiled from the published reports of the agricultural experiment stations and kindred institutions in this and other countries. The chief object of these publications is to disseminate thruout the country information regarding experiments at the different experiment stations, and thus to acquaint farmers in a general way with the progress of agricultural investigation on its practical side. The results herein reported should for the most part be regarded as tentative and suggestive rather than conclusive. Further experiments may modify them, and experience alone can show how far they will be useful in actual practise. The work of the stations must not be depended upon to produce "rules for farming." How to apply the results of experiments to his own conditions will ever remain the problem of the individual farmer.—A. C. TRUE, Director, Office of Experiment Stations.

## CONTENTS OF NO. XXXVII.


| | Page. |
|---|---|
| Breeding corn and the prevention of inbreeding | 5 |
| Buckwheat | 10 |
| Sugar beets on alkali soils | 14 |
| Alfilaria as a forage plant | 17 |
| Apple bitter rot | 21 |
| The grass-mulch method of orchard culture | 23 |
| Increasing the hardiness of young fruit trees | 26 |
| Protecting cows from flies | 28 |
| Effect of silage on the flavor or odor of milk | 29 |
| Cold storage of cheese | 31 |

# ILLUSTRATION.


| | Page. |
|---|---|
| Fig. 1. Alfilaria plants and seed | 18 |


267

# EXPERIMENT STATION WORK.[a]

## BREEDING CORN AND THE PREVENTION OF INBREEDING.[b]

At a number of experiment stations, especially those in the principal corn-growing States, work in corn breeding has been in progress for a series of years. Methods for carrying on this line of investigation have been perfected and their general application recommended to farmers. These directions for the selection of seed corn and the management of a breeding plat have already been summarized.[c] The more recent results in the continuation of breeding high-protein and low-protein corn at the Illinois Station again bring out the distinct individuality which each separate mother ear possesses and stamps upon the offspring. For instance, in the high-protein plat in 1902 row No. 5 produced 74.6 bushels and row No. 7 86.4 bushels per acre, or a difference of 11.8 bushels, while in 1904 row No. 22 produced 79.2 and row No. 24 96.4 bushels per acre, or a difference of 17.2 bushels per acre. This comparison of the different rows shows the influence the individuality of the seed may exert upon the yield. A test was also made of the method of chemical selection by mechanical examination in the hands of several practical farmers, and the results, showing in every case a gain made in average protein of the selected ears, demonstrated the success of the method and its application to farm practise.

In addition to the work in breeding high-protein and low-protein corn and studying the individuality of seed ears, experiments bearing upon the prevention of inbreeding were made, and the recommendations based upon the results obtained and applied with the directions already given for breeding corn are considered an improvement over the methods so far devised and as placing the work upon a more scientific basis. The row system of corn breeding, in which each row represents one individual seed ear, enables the breeder to determine accurately the productivity and general transmission of characters of each

[a] A progress record of experimental inquiries, published without assumption of responsibility by the Department for the correctness of the facts and conclusions reported by the stations.

[b] Compiled from Illinois Sta. Buls. 37, 100.

[c] U. S. Dept. Agr., Farmers' Bul. 193, p. 20.

ear used for seed; but he has no assurance that the seed he has grown is free from the effects due to self-pollination or close pollination, which are generally conceded to be injurious in naturally cross-pollinated plants like corn. In the row system as thus far worked out the usual possibility of self-pollination, together with an unusual possibility of close pollination, exists. In self-pollination the pollen from the male flowers, or tassel, of a given plant falls upon the female flowers, or silk, of the same plant. In close pollination the pollen from the male flowers of a given plant reaches the silk of another plant in the same row, and, as each row in the breeding plat represents one individual seed ear, these two plants originating from the same mother ear are closely related. In cross pollination, however, the pollen from the male flowers of one plant in a certain row is transferred to the female flowers of another plant in a different row, and these two plants under the particular system of plant breeding are therefore grown from seed from two different mother ears.

In order to entirely eliminate inbreeding or to bring its influence to a minimum, detasseling was practised in the breeding plat and a definite arrangement for the planting of the seed ears in alternate years was devised. The results of previous studies by the experiment stations on the effects of detasseling have in general left the advisability of the practise an open question. The earlier work of the Illinois Station in this line, carried on for the purpose of determining the value of detasseling in increasing the yield, altogether aside from its value as a feature in breeding seed corn, led to the belief that if the practise is beneficial at all it is most likely to be so on poor soil or in dry seasons; and it was, furthermore, shown that detasseling sometimes reduced the yield. The series of experiments in detasseling now reported has already been carried on for three years. During this period the even-numbered rows on two breeding plats, the one growing high-protein Leaming and the other low-protein Leaming corn and each containing 44 rows, were detasseled, and every succeeding year the even-numbered rows were planted with seed selected from the best detasseled rows and the odd-numbered with seed selected from the best tasseled rows. Each plat, therefore, contained 22 tasseled and 22 detasseled rows, and the seed was selected from the best 10 rows in each lot. The detasseled rows, owing to the absence of pollen, had no influence upon the breeding of the tasseled rows, but they themselves were necessarily crossbred each year, as is pointed out in the definition of cross pollination in the breeding plat, as the authors have given it. The tasseled rows, however, as indicated in the definition of close pollination, became more or less inbred, and the system of merely detasseling alternate rows in the breeding plat for the purpose of preventing inbreeding is therefore imperfect. Still, the results in the high-pro-

tein plat showed an average increase in favor of the detasseled rows of 1.6 bushels per acre the first year, 10.1 bushels the second year, and 9.3 bushels the third year, while the detasseled rows of the low-protein plat yielded 5.9 bushels less than the tasseled rows in the first year of the test and 14.7 and 11.8 bushels more the second and third years, respectively. Since the results from this imperfect system of crossbreeding, which was adopted to obtain comparative data from alternating rows in the same field, were beneficial, it is considered probable that even greater benefits would be obtained from a system in which the seed from both sire and dam is crossbred; and accordingly a practical commercial system insuring crossbreeding to the greatest possible extent was worked out.

It is recommended that the breeding plat be planted with the seed from 96 selected ears in 96 separate rows, that every alternate row be completely detasseled before the pollen matures, and that all of the seed corn be selected from the 48 detasseled rows. It is further advised to allow the tassel to develop sufficiently to be separated alone at the top joint by a careful pull. As the tassels are not all in the same stage of development, the rows must be gone over many times and the tassels pulled as they reach the right stage. No plants in any way imperfect should be allowed to mature pollen, and it may sometimes be necessary to detassel an entire row because of its general inferiority.

The breeding plat according to the proposed plan is divided into quarters, each containing 24 rows and each row representing a separate seed ear. The even-numbered rows are detasseled and 4 ears are selected for seed from each of the 6 best yielding detasseled rows in each quarter, making 96 ears in all. "It is recommended that these 96 seed ears be numbered from 1 to 48 and from 51 to 98, the numbers 49 and 50 being omitted; also that ears 1 to 48 be planted in one half of the plat and ears 51 to 98 be planted in the other half, preferably end to end with the first half, leaving one hill unplanted to mark the line between the two halves, also leaving one row unplanted to mark the line between rows 24 and 25 and between rows 74 and 75—that is, between quarters."

It is advised, however, to start the first year in the 100 series, numbering the ears to be planted in succession from 101 to 148, and from 151 to 198; the second year from 201 to 248 and from 251 to 298, and so on. The seed ears planted in the odd-numbered rows to produce tassels and to furnish pollen are referred to as "sire seed," and the seed ears for the even-numbered rows, which will contain the mother plants producing the future seed, are called "dam seed." Two of the 4 seed ears taken from each one of the selected rows are used for sire seed and 2 for dam seed.

The dam seed ears for each quarter are ears which grew in the same quarter, while the sire seed is always brought from another quarter. For the first quarter (rows 1 to 24) sire ears are brought from the fourth quarter. For the second quarter sire seed is brought from the third. In each of these cases sire seed is carried diagonally across the breeding plat. For the third quarter sire seed is brought from the first quarter, and for the fourth from the second, the sire seed being carried lengthwise of the breeding plat in these cases.

An instance of the order of planting the first quarter of a plat is given by way of illustration. It is assumed that, of the rows Nos. 1 to 24, which always constitute the first quarter, Nos. 2, 4, 6, 8, 10, and 12 were the six best yielding rows, each furnishing 2 dam seed ears and 2 sire seed ears. The 12 ears of dam seed bearing the numbers of the rows from which they were taken are used for planting the even-numbered rows of the quarter, the order, beginning with row No. 2, being 2, 6, 10, 4, 8, 12, 2, 6, 10, 4, 8, 12, or the alternating numbers repeated in sets of 3 and 6.

The odd-numbered rows of this quarter are planted with 12 sire ears, representing the 6 selected rows of the fourth quarter, and each ear also bearing the number of the row in which it grew. The numbers of these rows in the case given are 76, 78, 80, 82, 84, 86, and the order of planting the ears, beginning with row No. 1, is as follows: 76, 80, 84, 78, 82, 86, 78, 82, 86, 76, 80, 84. The order is the same as for the dam seed ears, with the exception that the 2 sets of 3 are reversed in the second set of 6.

For the odd-numbered years the 2 sets of 6 in planting the sire seed are transposed, which then makes the order 78, 82, 86, 76, 80, 84, 76, 80, 84, 78, 82, 86. The order of planting, exactly the same in each quarter of the breeding plat, is fully illustrated in the plan on the following page, in which the figures under "guide systems" designate the plat rows from which the seed ears were taken. It is to be remembered in this connection that all even-numbered rows are detasseled and that no seed ears are saved from odd-numbered rows. The heavy-faced figures in the plan represent the "sire seed."

If, for example, the best 6 rows of the first quarter of the breeding plat are 4, 8, 10, 14, 16, 20, then these numbers in ascending order are substituted for the numbers 2, 4, 6, 8, 10, and 12, as given in the following plan under "Model example for an even year."

*Plan for planting the breeding plat to avoid inbreeding.*

| 1st quarter. | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Plat row No. | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 |
| Guide system for even years | 76 | 2 | 80 | 6 | 84 | 10 | 78 | 4 | 82 | 8 | 86 | 12 | 78 | 2 | 82 | 6 | 86 | 10 | 76 | 4 | 80 | 8 | 84 | 12 |
| Guide system for odd years | 78 | 2 | 82 | 6 | 86 | 10 | 76 | 4 | 80 | 8 | 84 | 12 | 76 | 2 | 80 | 6 | 84 | 10 | 78 | 4 | 82 | 8 | 86 | 12 |
| Model example for an even year | 76 | 4 | 84 | 10 | 90 | 16 | 80 | 8 | 86 | 14 | 92 | 20 | 80 | 4 | 86 | 10 | 92 | 16 | 76 | 8 | 84 | 14 | 90 | 20 |

| 2d quarter. | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Plat row No. | 25 | 26 | 27 | 28 | 29 | 30 | 31 | 32 | 33 | 34 | 35 | 36 | 37 | 38 | 39 | 40 | 41 | 42 | 43 | 44 | 45 | 46 | 47 | 48 |
| Guide system for even years | 52 | 26 | 56 | 30 | 60 | 34 | 54 | 28 | 58 | 32 | 62 | 36 | 54 | 26 | 58 | 30 | 62 | 34 | 52 | 28 | 56 | 32 | 60 | 36 |
| Guide system for odd years | 54 | 26 | 58 | 30 | 62 | 34 | 52 | 28 | 56 | 32 | 60 | 36 | 52 | 26 | 56 | 30 | 60 | 34 | 54 | 28 | 58 | 32 | 62 | 36 |
| Model example for an even year | 52 | 30 | 58 | 36 | 66 | 42 | 56 | 34 | 60 | 38 | 68 | 46 | 56 | 30 | 60 | 36 | 68 | 42 | 52 | 34 | 58 | 38 | 66 | 46 |

| 3d quarter. | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Plat row No. | 51 | 52 | 53 | 54 | 55 | 56 | 57 | 58 | 59 | 60 | 61 | 62 | 63 | 64 | 65 | 66 | 67 | 68 | 69 | 70 | 71 | 72 | 73 | 74 |
| Guide system for even years | 2 | 52 | 6 | 56 | 10 | 60 | 4 | 54 | 8 | 58 | 12 | 62 | 4 | 52 | 8 | 56 | 12 | 60 | 2 | 54 | 6 | 58 | 10 | 62 |
| Guide system for odd years | 4 | 52 | 8 | 56 | 12 | 60 | 2 | 54 | 6 | 58 | 10 | 62 | 2 | 52 | 6 | 56 | 10 | 60 | 4 | 54 | 8 | 58 | 12 | 62 |
| Model example for an even year | 4 | 52 | 10 | 58 | 16 | 66 | 8 | 56 | 14 | 60 | 20 | 68 | 8 | 52 | 14 | 58 | 20 | 66 | 4 | 56 | 10 | 60 | 16 | 68 |

| 4th quarter. | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Plat row No. | 75 | 76 | 77 | 78 | 79 | 80 | 81 | 82 | 83 | 84 | 85 | 86 | 87 | 88 | 89 | 90 | 91 | 92 | 93 | 94 | 95 | 96 | 97 | 98 |
| Guide system for even years | 26 | 76 | 30 | 80 | 34 | 84 | 28 | 78 | 32 | 82 | 36 | 86 | 28 | 76 | 32 | 80 | 36 | 84 | 26 | 78 | 30 | 82 | 34 | 86 |
| Guide system for odd years | 28 | 76 | 32 | 80 | 36 | 84 | 26 | 78 | 30 | 82 | 34 | 86 | 26 | 76 | 30 | 80 | 34 | 84 | 28 | 78 | 32 | 82 | 36 | 86 |
| Model example for an even year | 30 | 76 | 36 | 84 | 42 | 90 | 34 | 80 | 38 | 86 | 46 | 92 | 34 | 76 | 38 | 84 | 46 | 90 | 30 | 80 | 36 | 86 | 42 | 92 |

For the purpose of description it is recommended that upon selection each individual ear be given a register number representing that particular ear only and for all time. In addition, the length, tip and butt circumference of ear, number of rows of kernels, number of kernels in the row, weight of ear, weight of cob, tip and butt circumference of cob, and percentage of protein and oil in the grain are to be determined. It is further advised that for the sake of convenience the number of the plat row or breeding row should correspond with the register number of the ears planted, and that in the performance record of each plat row the yield of corn in pounds per row and in bushels per acre, the number of ears in the row, and the percentage of protein and oil in the grain be given.

## BUCKWHEAT.[a]

Buckwheat is not extensively grown in this country, as the demand for the grain is not very large, but other uses of the crop, as well as its adaptation to meet certain conditions, may make it of value at times to any farmer in a region suited to its culture. Of the 24 States reporting buckwheat production in 1905 only 5—Minnesota, Iowa, Missouri, Kansas, and Nebraska—are west of the Mississippi. The culture of the crop is further limited to certain localities, mainly in the northeastern States, and the total yield for the entire country is small as compared with the yields of our principal crops. In 1905 the United States produced 14,585,082 bushels on 765,118 acres, the average yield per acre being 19.2 bushels. At an average price of 60 cents per bushel this crop was worth $8,751,049.20. Over two-thirds of the entire crop was grown in New York and Pennsylvania, and the greater portion of the remainder was produced in Maine, Michigan, West Virginia, Wisconsin, and Virginia, mentioned in the descending order of total yield. From 1866 to 1869, inclusive, over a million acres of buckwheat were grown annually, but since that time the acreage has not past the million mark. In quantity produced, buckwheat is the least important of our six principal grain crops, but it is nevertheless of value as a source of food and feeding stuffs, and is very profitably grown for green manure, as a catch crop, and for the improvement of the mechanical condition of the soil. The advantages of buckwheat culture, pointed out in detail by J. L. Stone in a recent bulletin of the New York Cornell Experiment Station, together with directions for growing the crop, are here summarized.

Buckwheat is an annual, erect in habit, ordinarily growing about 3 feet high. It has a long taproot with comparatively few branch roots. The stem is from one-fourth to five-eighths of an inch thick, and varies in color from green to purplish red, changing to brown at

[a] Compiled from N. Y. Cornell Sta. Bul. 238; West Virginia Sta. Bul. 84.

maturity. The plant does not stool as the cereal grains. Each seed produces a single stem, and instead of stooling or tillering it branches more or less freely, as the thickness of seeding will permit. The grain has a thick, hard, smooth, and shining hull, varying in color from silver gray to brown or black. In the chief buckwheat-growing States the usual weight of the grain per bushel is 48 pounds.

Buckwheat belongs to the Polygonaceæ, a family including such well-known weeds as dock and smartweed. The cultivated forms have been assigned to three species, common or true buckwheat (*Fagopyrum esculentum*), the most valuable and most widely grown form; notch-seeded buckwheat (*F. emarginatum*), and Tartary or Siberian buckwheat (*F. tartaricum*). The notch-seeded form is not very widely distributed.

Buckwheat prefers a moist, cool climate, and matures in 8 to 10 weeks, and is thus well adapted to high altitudes and short seasons. It grows on many different kinds of soil and succeeds fairly well on soils too poor for other crops, but the largest yields are obtained on fertile, well-drained, sandy loams. The crop is not specially adapted to heavy clays or wet lands, and on very rich soils it lodges readily, and when once lodged does not rise again. Heavy applications of barnyard manure or of nitrogenous fertilizers are seldom profitable, as they increase the tendency to lodge, but the use of lime and phosphoric acid has been found very beneficial. In experiments conducted by the West Virginia Experiment Station a few years ago the use of 400 pounds of acid phosphate per acre apparently almost doubled the yield during two seasons, while the third season the increase in yield was small when this substance was used in excess of 150 pounds per acre. In this same series of experiments a plat having received 30 bushels of stone lime per acre in 1899 yielded 32.1 bushels of buckwheat per acre in 1901, as compared with 22.7 bushels on the check plat.

A good preparation of the seed bed aids very materially in securing profitable yields. Early plowing, to allow the ground to settle before the seed is put in, is recommended. Three pecks of seed per acre is sufficient on good soil, but on land of low fertility from 4 to 5 pecks is used. The seed is sown with the ordinary grain drill or broadcasted and covered with the harrow. In southern localities buckwheat is sown from May to September, while in the North the seeding period is much shorter, extending from June 15 to about July 10. Hot weather and frost are both injurious to the crop while the grain is forming, and hence it is desirable to sow as late as possible, provided sufficient time is allowed for the grain to mature before frosts occur. The plant blossoms for three weeks or more, and the kernels ripen unevenly. Harvesting is begun soon after

the first seeds are ripe, but at this time the same plant often contains mature and immature grain and blossoms. The immature grain ripens in the swath, while if the crop is not harvested at this stage much of the mature grain will shell out in handling. Buckwheat is generally cut with the hand cradle or the dropper reaping machine, the self-binder being rarely used. Cutting early in the morning or in damp, cloudy weather prevents the loss of the ripe grains. The crop is left to cure in the swath for a few days and is then set up in small shocks. If bound at all the sheaves must be small and loosely tied to facilitate drying. Threshing may be done as soon as the crop is cured. Buckwheat threshes easily, and in order to avoid cracking the grain and unnecessarily breaking the straw the spiked concave is removed from the machine and a smooth one put in its place.

The varieties generally grown are the Common Gray, Silver Hull, and Japanese. The seed of the Silver Hull is slightly smaller and lighter in color than the Common Gray, while that of the Japanese is larger than the Common Gray, darker in color, and the edges of the hull show a tendency to extend into a wing. The Japanese is generally regarded as the best yielding variety. In an experiment at the Cornell Station the average yields per acre for the three varieties were as follows: Japanese, 27.5 bushels; Common Gray, 26.8 bushels, and Silver Hull, 19.5 bushels. Yields of 30 to 40 bushels per acre are sometimes obtained.

The buckwheat crop is quite free from interference from weeds, plant diseases, and insects. The crop is well adapted to green manuring, because it thrives on quite poor soil, grows rapidly, smothers out weeds, leaves hard soils in a mellow condition, and decays quickly when plowed under. The straw when spread out on the land also soon decays and makes a good fertilizer. Buckwheat has usually no definite place in the crop rotation, as it is largely grown as a substitute for meadow or spring-planted crops that have failed. It is stated that while buckwheat is not materially affected by the crop that precedes it, oats and corn are regarded as being less successful after buckwheat than after other crops. A crop of buckwheat leaves the soil in a peculiarly mellow condition, and in many localities with rather heavy soils advantage is taken of this fact by following it with potatoes. The following rotation is given as sometimes recommended for heavy soils: Clover, buckwheat, potatoes, oats or wheat with clover. The clover is harvested early and immediately followed by buckwheat as a preparation for the potato crop.

The composition of the grain and other parts of the buckwheat plant, as compiled by T. F. Hunt, is as follows:

*Composition of the grain, straw, flour, middlings, and hulls of buckwheat.*

| Material. | Water. | Protein (N×6.25). | Fat. | Nitrogen-free extract. | Crude fiber. | Ash. |
|---|---|---|---|---|---|---|
| | *Per cent.* | *Per cent.* | *Per cent.* | *Per cent.* | *Per cent.* | *Per cent.* |
| Grain | 12.6 | 10.0 | 2.2 | 64.5 | 8.7 | 2.0 |
| Straw | 9.9 | 5.2 | 1.3 | 35.1 | 43.0 | 5.5 |
| Flour | 14.6 | 6.9 | 1.4 | 75.8 | .3 | 1.0 |
| Middlings | 12.7 | 28.1 | 7.0 | 42.4 | 4.2 | 5.1 |
| Hulls | 10.1 | 4.6 | .9 | 37.7 | 44.7 | 2.0 |

The grain has a high percentage of crude fiber and a somewhat lower percentage of protein and nitrogen-free extract than wheat. The straw is somewhat higher in protein and crude fiber and lower in nitrogen-free extract than wheat straw. The hulls, which give to the grain its high crude fiber content, are hard and indigestible, and have little feeding value.

The buckwheat grain and its various by-products are used to some extent for feeding farm animals as are the green plant and the straw. The crop is also grown as a bee plant, as the blossoms contain considerable honey, Japanese buckwheat being especially satisfactory for the purpose. Buckwheat has been successfully fed to pigs but was not found to be quite equal to wheat for the purpose. It does not appear, as is sometimes claimed, that it is the cause of soft pork.[a] The grain is also used as a poultry feed. The hulls are woody and are worth little as a feeding stuff. The portion next to the hull, which is known as middlings, has a high feeding value. Buckwheat bran, which is a mixture of the hulls and middlings, is inferior to the middlings on account of the admixture of hulls. Both the bran and middlings are fed to dairy cows. The flour, at usual prices, may be regarded as an economical feeding stuff. The green forage, it is said, is sometimes injurious to sheep.

Buckwheat flour is used very largely in the United States for making pancakes or griddlecakes and less commonly as a breadstuff and in other ways. In Russia buckwheat porridge is a common article of diet. In recent years the manufacture of "ready-to-use" buckwheat flours containing leavening materials has become an industry of considerable importance, the goods being usually sold in packages. Buckwheat farina and buckwheat groats are also on the market, but are used in much smaller quantities than the flour. As regards total nutritive value, the buckwheat flour and similar goods contain less protein and rather more carbohydrates than wheat flour and other oat, corn, and wheat products commonly used as food.

According to a recent publication of the Bureau of Chemistry,[b] buckwheat flour is frequently adulterated with cheaper cereal products.

[a] Canada Expt. Farms Rpts. 1895.

[b] U. S. Dept. Agr., Bureau of Chemistry Bul. 100, p. 19.

## SUGAR BEETS ON ALKALI SOILS.[a]

Observations on the growth of sugar beets on alkali soils were begun by the California Station in southern California more than ten years ago, and since that time further experiments have been carried on by this institution and data confirming previous results with additional information on the subject have accumulated. The earlier results have been previously described.[b] The work here presented is taken from a bulletin by G. W. Shaw, of the California Station, in which his results of investigation along this line are summarized. Investigations made by the author of the bulletin in 1900 at Grand Junction, Colo., and continued in 1904 at Oxnard, Cal., are reviewed.

Soil analyses, together with field observations and the experience in the application of water in Colorado, seem to indicate that in the virgin soil the heavy percentage of alkali lies above the fourth foot, and that the excessive amounts now found in the surface foot have been brought there from that depth by shallow irrigation and by an upward leaching of the soil caused by underground seepage from irrigation canals, especially where soil conditions are favorable to this action. The average of 8 soluble salt determinations upon Colorado soils producing either good or fair crops of beets show a percentage of 0.036 of chlorids, 0.004 of carbonates, and 0.087 of sulfates, or a total of 0.127 per cent in the upper foot of the fields under observation. These percentages calculated to absolute quantities mean that the top foot of an acre of such soils contained 1,440 pounds of chlorids, 160 pounds of carbonates, and 3,480 pounds of sulfates, or a total of 5,080 pounds of soluble salts. While the yields of beets were not high, they were above the average for the region, being 8.45 tons per acre on an average, and ranging from 7.76 tons to 20.98 tons, with an average sugar content of 16.03 per cent and a purity of 81.8. The inference from these data is that while the soluble salt content of the beet is high, fair and even good beets can be produced in a soil whose total alkali content may reach 5,000 pounds in the surface foot per acre, other conditions being favorable.

Similar observations made on soils producing poor crops of beets under the same conditions of cultivation and treatment, and based on an estimate that the Grand Junction soil carries three-fourths of the alkali in the top foot, brought out the fact that where beets failed the top foot of soil in 15 out of 16 samples carried much more chlorid than the 3 upper feet of the soils producing a fair crop, as described above. The single soil sample in which the chlorids were

[a] Compiled from California Sta. Bul. 169.

[b] U. S. Dept. Agr., Farmers' Bul. 92, p. 5.

low contained only 840 pounds per acre in the top foot, but the sulfates rose to 9,400 pounds. These results point to the soluble salt content of the soil as the primary cause of the failures of beets on these soils, but the high percentage of alkali is not uniform thruout the locality, and by avoiding those soils with an alkali content above the tolerance of the plant these difficulties in sugar-beet culture may be obviated.

Beet fields subject to alkali are described as being characterized by a very uneven stand, considerable irregularity in the size of the plants, and the prevalence of chlorosis of the older leaves and of sprangling taproots. The cause given for these effects is that the alkali retards or prevents the germination of the seed, or that it destroys the plants after germination. Clay soils were found to present greater difficulties in this respect than sandy soils. Attention is called to the fact that when the density of the soil solution becomes too great the vitality of the seed is destroyed; or, in the case of already growing plants, the passage of water from the soil into the plant is checked. The strength of the soil solution in the Colorado analyses was found to be 2.97 per cent of alkali where the soil moisture was equal to 20 per cent and to 5.86 where it was only 10 per cent. On the field in question the heavy adobe soil two days after irrigation contained from 18 to 20 per cent of water on the side of the plant next the water furrow, but several days after irrigation the moisture content had fallen to 8 to 12 per cent, and the plants, while still growing, were suffering from lack of water.

Experiments by E. E. Slosson and B. C. Buffum, of the Wyoming Station,[a] showed that the retarding effect of a salt solution on the germination of seeds, aside from other factors, is in direct proportion to its osmotic pressure, and it is concluded that in all cases the salt solution hinders the absorption of water by plants in a ratio increasing with its osmotic pressure. Slosson estimates that in 1 per cent solutions sodium chlorid exerts an osmotic pressure of 7.4 atmospheres, sodium carbonate of 4.3, sodium sulfate of 3.9, and magnesium sulfate of 2.8, as compared with a pressure of 0.7 for sugar.

At Oxnard, Cal., observations were made in a number of beet fields with a marked unevenness of stand. These fields were cross-sectioned and the alkali content in the various portions determined. The results secured in one field indicated that wherever the chlorid content of the soil approached 0.20 per cent the beets were either very much stunted or entirely destroyed. In other parts where the chlorid content was decidedly low, the beets were of a better size but still of poor form. This is regarded as showing the comparatively

[a] Wyoming Sta. Rpts. 1899, pp. 1–40, 1–29; 1900, pp. 1–15.

limited effect of the sulfates on the growth of the beets and their great sensitiveness to the soluble chlorids. This fact is brought out more clearly in the following table:

*The effect of different percentages of soluble salts on the growth of sugar beets.*

| Condition of beets. | Sulfates. | Carbonates. | Chlorids. | Total salts. |
|---|---|---|---|---|
| | *Per cent.* | *Per cent.* | *Per cent.* | *Per cent.* |
| No growth | 0.4063 | 0.0092 | 0.1957 | 0.6112 |
| Poor | .3602 | .0000 | .0742 | .4344 |
| Fair | .2010 | .0044 | .0746 | .2800 |
| Good | .2629 | .0101 | .0419 | .3149 |

The sugar content of the beets on this field ranged approximately from 17 to 22 per cent.

In another field in which the conditions were similar to those in the field just referred to, but which was subirrigated, the beets were a much better size. Spots producing good beets alternated with spots producing no beets, but no apparent connection was found between the growth of good beets and the percentage of either total alkali or sulfate within the limits shown on this field except as influenced by the chlorids. It is further pointed out that on a certain portion where good beets were produced practically all the alkali was contained in the top foot of soil, where it could have little or no effect on the more delicate feeding roots of the plant which extend below the surface foot. Adjacent to this part of the field, on a spot producing no beets, the concentration of the alkali was essentially the same in the first and second foot of soil, which brought it within reach of the fibrous feeding roots of the plants. This fact, which indicates that the distribution of the soluble salts may exert as great or even a greater influence on the growth of beets than the total quantity of alkali present, is regarded as explaining why beets fail to grow on certain spots altho little or no alkali appears near the surface; or why in other cases the plants fail even tho the seed germinated well and a good stand was originally obtained. A heavy concentration of alkali near the surface interferes with the germination of the seed, while its concentration lower down in the soil interferes with the growth of the plant.

The influence of the distribution of salts around the feeding roots was studied on another field, special attention being given to the distribution of chlorids. In this field the beets were irregular in size and the best beets were produced on the lower spots where the irrigation water seemed to have stood, while on the ridges the characteristic "alkalied" beets—small, sprangly, and stubby—were found. Determinations of the alkali content showed that on the soil of the low spots the chlorids were below 0.15 per cent, while on the ridges they exceeded 0.20 per cent. In the low spots the concentration of

alkali was greatest in the first foot, while on the ridges it was even greater in the second and third foot than in the first. These results seemed to confirm those secured on the other field with reference to the relation of the feeding roots of the beet to the distribution of the injurious soluble salts. In these observations fair beets were found growing in soil with an average of 4,000 pounds of chlorid per acre-foot. The water content of the soil on the ridges was found to be considerably higher than that of the lower spots, owing, as pointed out, to the higher alkali content which renders soils more retentive of water. This moisture, however, owing to the high concentration of the soil solution may be but little available to the plant.

An examination made on still another field showed that beets of fair size and good quality were grown on a soil containing nearly 1 per cent of soluble salts, of which 0.86 per cent was in the form of sulfates, but that poor beets resulted as soon as the chlorid content of the soil reached 0.20 per cent, altho the total alkali and the sulfates decreased to 0.40 and 0.21 per cent, respectively.

The author reports having found among badly "alkalied" beets individual beets presenting a strong and healthy growth, of good form and quality, and he believes that the problem of beet culture on alkali soils calls for the proper selection and preparation of the soil and the development of a more alkali-resistant sugar beet. He is of the opinion that the careful selection and preparation of soil and "the development of a more alkali-resistant beet would make it possible to considerably extend the area now available, and bring under cultivation to a generally profitable yield a large amount of land for which it is now difficult to find satisfactory crops."

## ALFILARIA AS A FORAGE PLANT.[a]

One of the principal lines of experiment station work in the Southwest is the study of various forage plants, either introduced or indigenous, as means of restoring the overstocked range or otherwise increasing the forage production of the grazing areas. During the last five years the problem of range improvement has received particular attention in Arizona, where the experiment station, working partly in cooperation with this Department, has secured results showing the practicability of improving the ranges by the introduction of forage plants adapted to the region, by encouraging the dissemination of all species of economic value, and by proper management in general.

Of the introduced plants, alfilaria, also known as alfilerilla, filaree, pin clover, etc. (fig. 1), is so well adapted to the prevailing climatic

[a] Compiled from Arizona Sta. Bul. 52.

conditions and has proved itself of such great value as a range plant that it is considered as ranking first in merit. The plant is a native of the Mediterranean region and was presumably introduced into California

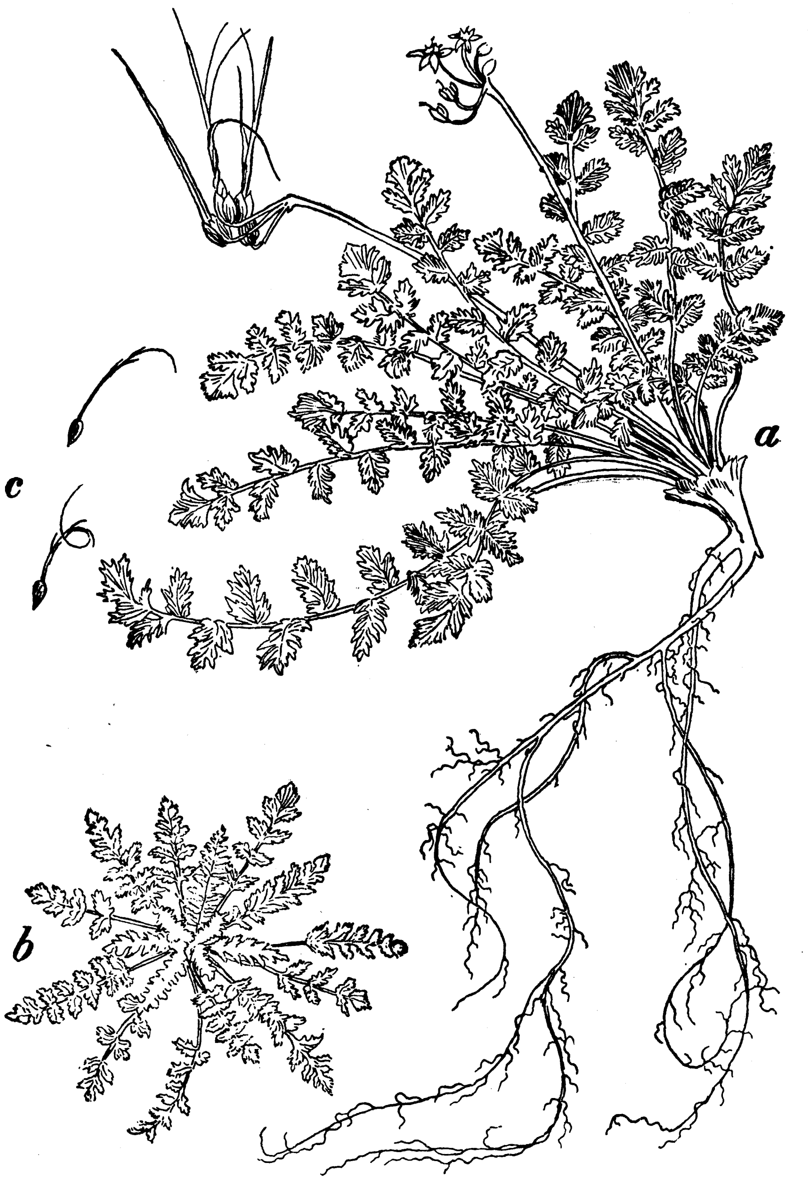


FIG. 1.—Alfilaria plant and seed: *a*, Young plant, about one-third natural size, most of the leaves and roots cut away; *b*, seven-weeks old rosette, about one-third natural size; *c*, the awned seeds.

by the early Spanish explorers. It is at present permanently established in Oregon, California, Nevada, Arizona, New Mexico, Utah, and parts of Washington, Idaho, and Texas, an area having generally mild

winters and more or less fall and winter rains. Outside of this territory its distribution is not so general and the plant is of little importance. It was introduced into Arizona from California about the beginning of the sixties, but ten years later it was brought on a much larger scale in connection with traffic between the two regions. The main factor in its introduction was the stock, and especially sheep, which was driven from southern California to Arizona to secure better pasturage, and which carried the seed in their hairy coats. Even to-day the plant is most abundant along the old highways antedating the railways and the localities in which the sheep driven from California were herded.

There are about eight species of alfilaria growing in the United States, three being native to the Pacific coast region. The most valuable and the one that has made such progress on the ranges is the red-stemmed alfilaria (*Erodium cicutarium*). This species is a hairy, slightly viscid, erect or ascending herbaceous winter annual, from 6 to 8 inches high. Its flowers are lilac or purple, and the plant possesses generally a pronounced musky odor. During the winter it forms a compact, many-leaved rosette, from 10 to 12 inches in diameter, from which the stems are thrown up during the spring months.

The factors influencing its growth are given as mild-winter temperatures, winter precipitation, altitudes as bearing on precipitation and temperature, and to some extent soil conditions. It is estimated that from 5 to 7 inches of winter and spring rainfall is necessary to produce a good growth. Two to 3 inches of rain from December to February, inclusive, will start and maintain winter growth, and one-half inch or more during March or April will give considerable forage; but a greater precipitation, especially during the spring, will much increase the growth of this plant, as well as that of the native species. The mild winters of the region favor the growth of winter annuals, and when the soil moisture is adequate alfilaria seeds germinate readily during the season. It has been observed that the plants thrive best at elevations ranging from 1,500 to 4,000 feet. It grows on a wide range of soils in different parts of Arizona and seems to thrive on any soil manifestly free from alkali. The characters of the plant are so well adapted to the Southwest that it grows better than many native annual species under the same conditions, and it is reported to be more abundant and more generally distributed thruout that region than any other introduced species.

The advantage of alfilaria over other plants consists in its growth in the late fall and winter, when moisture conditions are most uniform. The seedling plants develop quickly at this time, their leaf surface continues to increase slowly during the winter, and a rather deep, thick taproot is formed. The plant blossoms in late winter and then

throws up several vigorous stems and keeps on growing until April or May. This early growth enables it to mature seed before the dry season sets in. The seeds remain apparently in an unchanged condition during the summer months; at least they do not germinate during this period, even in the presence of a considerable quantity of moisture. They stick to the furry coats of animals and are in this way very readily disseminated. They are provided with spirally-twisted awns, which coil and uncoil as the atmospheric moisture conditions change, and by this action work themselves into the ground, literally planting themselves. This feature also prevents them from being blown or washt away. Alfilaria furnishes forage from February to June, and covers the period from winter until the summer species of range plants have made sufficient growth for grazing.

On the richer soils of valleys, swales, and similar favorable areas, where the plant produces a heavy, continuous growth from 12 to 18 inches in height, it is also used for hay, being cut when in blossom. Under very favorable moisture conditions from 1½ to 2 tons of hay per acre have been secured, but ordinarily 1½ tons is regarded as a fair yield, even in the best locations. The chemical composition of alfilaria as range forage and as hay is given in the following table, and compared with the composition of alfalfa hay produced on the Arizona Station farm:

*The composition of the green forage and hay f alfilaria compared with that of alfalfa hay.*

| Sample. | Water. | Ash. | Protein (N × 6.25). | Crude fiber. | Nitrogen-free extract. | Fat. |
|---|---|---|---|---|---|---|
| | *Per cent.* | *Per cent.* | *Per cent.* | *Per cent.* | *Per cent.* | *Per cent.* |
| Alfilaria in seed | 81.53 | 3.52 | 2.38 | 4.46 | 7.82 | 0.39 |
| Hay, good quality | 8.88 | 13.30 | 13.49 | 20.55 | 41.58 | 2.20 |
| In rosette stage | 85.84 | 2.48 | 3.99 | 1.39 | 5.88 | .42 |
| Damaged hay | 11.60 | 11.93 | 7.78 | 27.97 | 38.56 | 2.16 |
| Alfalfa hay | 6.66 | 6.34 | 11.61 | 34.73 | 38.95 | 1.71 |

The sample of alfilaria in seed was pulled by the roots April 29, while mostly in seed but still flowering. The rosette sample was taken just previous to blossoming. The rosettes were 4 to 8 inches in diameter, and were cut from the root at its crown. Attention is called to the fact that the plant contains a high percentage of ash, a factor considered favorable to the production of strong, healthy bone in growing animals, and that the protein content is very high and compares favorably with that of hay from leguminous crops. In the rosette stage it is found to form an excellent feed for range stock, but not as fattening as the nearly matured forage or the hay.

Two methods of spreading and introducing alfilaria are considered, one by means of sowing the seed, and the other by alternately herding sheep on areas producing alfilaria and on those on which it has not yet become established. The experience of some of the ranchers

indicates that the seed should be sown from November to January, covered not more than a quarter of an inch deep, and well prest with a roller. Rains to keep it moist or rather wet are necessary until it gets about 4 inches high, after which very little rain is needed. About 3 pounds of seed are considered sufficient to sow an acre. The seed sells for $1 a pound, but it is estimated that in a good alfilaria region two men can collect from 40 to 50 bushels of reasonably clean seed in four days. The seed is frequently sown on the unplowed ground, the covering being done by simply harrowing. The station observed that seeds stored in sacks in buildings during the summer months are very low in germination, and it is advised to sow them in favorable areas as soon after collecting as convenient. Introduction by seed sowing, however, is apparently a slow and tedious process, and it is believed that the spread of the plant is more rapid where it is disseminated by means of sheep and other similar grazing animals.

Introduction can be brought about quickest and with the greatest degree of success in a new locality if a drove of sheep that have been grazed in an alfilaria country are herded over it. Where possible, they should be allowed to graze alternately, first on the one and then on the other area. Some stockmen even maintain that it is only necessary to drive such a herd of sheep thru a country once or twice in order to seed it sufficiently.

Alfilaria combines several of the essential features which go to make up a good forage plant, viz, minute adaptability to environment, so as to prove successful in competition with other plants, production of a liberal amount of nutritious forage, rapid spread over new country with minimum expense, and maturation of viable seeds which may be collected in large quantity economically.

## APPLE BITTER ROT.[a]

The apple bitter or ripe rot is the cause of some of the most extensive losses experienced by apple growers. It is due to a fungus which has been given a number of scientific names, the one by which it is now known being *Glomerella rufomaculans*. The disease occurs thruout nearly all the country east of Kansas and Texas, and is especially destructive in a broad belt from Virginia to Oklahoma. It is somewhat spasmodic in its occurrence and at times occasions almost total loss. It is stated that in four counties in Illinois in 1900 the loss, due to this cause alone, amounted to $1,500,000, and the estimated loss to the apple crop for the United States during the same year was $10,000,000.

The fungus lives on many different plants, causing a ripe rot of their fruits, but is best known as causing the bitter rot of apples and the ripe rot of grapes. The first signs of the bitter rot on the apple are to be seen in a slight light-brown discoloration under the skin of the fruit. The spots increase rapidly in size, maintaining a more or less circular outline, and become darker brown in color. Soon the tissues

[a] Compiled from Illinois Sta. Bul. 77, Circs. 58, 67; Virginia Sta. Bul. 142; U. S. Dept. Agr., Bureau of Plant Industry Buls. 44, 93.

underneath the spots soften and the area seems sunken. When the spots have attained a diameter of about half an inch small black spots appear beneath the upper surface, thru which they finally break, discharging pink masses of spores which are very sticky when moist. These black pustules are usually formed in rings, and as the spots increase in size a number of concentric rings may be seen. The brown coloration of the spots is an indication of the decayed condition of the tissues underneath, and there is usually a sharp dividing line between the sound and the diseased tissues. The fruit is seldom entirely destroyed altho it is rendered almost worthless. The tissues are at first hard, followed by the breaking down of the cells, and the partially decayed portions usually have a pronounced bitter flavor, from which is derived the name bitter rot. The fruits never become excessively soft and mushy, but often dry into what are called "mummy" fruits.

It has been claimed that the fungus passes the winter in these fruits, spreading the infection the next season. While the spread of the fungus may be favored by the presence of the mummy fruits, yet a more important method has been found in the presence of cankers on the limbs of the trees. These are due to the same fungus as that occurring on the fruits, and their relation to the disease has been well established by Burrill and Blair, of the Illinois Station, and von Schrenk and Spaulding, of the Bureau of Plant Industry of this Department. From these cankers the spores are washed by the rains over the young fruits, causing their infection. The spread of the disease may often be traced to its source by the conelike infected area, with the canker at the apex. Alwood, of the Virginia Station, claims that infection sometimes takes place without the presence of cankers, and he thinks that mummy fruits are the principal source of primary infection. In the publications, both of the Illinois Station and the Bureau of Plant Industry, the authors recommend cutting out the cankers and thoro spraying of the trees with Bordeaux mixture, but Alwood advises caution in pruning, unless it can be done without material injury to the tree.

Marked differences in susceptibility of varieties to bitter rot have been noted. While no list can be given that will apply to all regions, yet in general the Yellow Newtown or Albemarle Pippin, Rhode Island, Willow, Huntsman, Northern Spy, Ben Davis, York Imperial, Grimes, and Winesap are subject to the disease almost in the order of enumeration, the Yellow Newtown seeming to be most liable to serious loss.

Certain conditions of weather influence the spread of the disease. It is favored by a hot, moist temperature, the fungus being very dependent upon the combination of high temperature and moisture for its development. During cool, dry summers little of the disease

may be expected, and an outbreak may be checked if the mean temperature falls to and remains at or below 70° F. for a few days.

W. M. Scott, of the Bureau of Plant Industry of this Department,[a] gives an account of spraying experiments for the control of the bitter rot on apples. These experiments were carried on in 1905 on an orchard of Yellow Newtown or Albemarle Pippin trees in Virginia, and the conditions that season were so favorable for the development of bitter rot, as was shown by the large number of decayed fruits on unsprayed trees, that the conclusions are believed to be of general application. The Bordeaux mixture used in the experiments was composed of 5 pounds of copper sulfate, 5 pounds of lime, and 50 gallons of water. It is shown that bitter rot can be controlled by four applications of Bordeaux mixture if applied at the proper times and in a thoro manner. The first application should be made about five or six weeks after the trees bloom, followed by others at intervals of about two weeks. By this method the experimenter was able to save from 93 to 98 per cent of sound fruit on the trees, while on adjoining trees that were not sprayed the fruit was a total loss. In dry, cool seasons the intervals between the later sprayings may be increased, while in hot, moist summers the intervals should be shortened and the number of applications increased. If for any reason the spraying is not begun until after the bitter rot has made its appearance on the young fruit, the trees should be given at intervals of only a few days two thoro sprayings, to be followed by applications as described above.

By beginning the spraying with the swelling of the buds and following at intervals of about two weeks until about eight applications have been given the trees, attacks of apple scab, leaf blotch, and sooty mold may also be prevented.

## THE GRASS-MULCH METHOD OF ORCHARD CULTURE.

The method of orchard culture now commonly accepted by horticultural investigators in eastern United States, and recommended as sound, is to clean cultivate early in spring up to the middle of summer, then seed the orchard down to a cover crop. This cover crop in its fall growth tends to evaporate the moisture from the soil, checking the growth of the trees and hastening the ripening of the wood, so that the trees enter the winter in a well-matured and frost-resistant condition. This method has been variously modified in different sections of the country to fit in with local conditions, but the idea of thoro cultivation in the orchard, for at least a part of the season, has been regarded as essential to the highest success.

---

[a] U. S. Dept. Agr., Bureau of Plant Industry Bul. 93.

[b] Compiled from Ohio Sta. Bul. 171.

Against this view has been the practise of a few successful orchardists, who have kept their orchards continuously in sod, cutting the grass each season and letting it lie on the ground or raking it up around the trees as a mulch. A preliminary report upon a systematic test of the merits of these two methods of orchard culture has recently been made by W. J. Green and F. H. Ballou, of the Ohio Station.[a] The work was begun in 1900, when the trees were first set out, and has been carried on up to the present time. On one plat the usual clean cultivation and cover-crop method of culture was observed. On another plat the ground was kept clean cultivated thruout the entire season. On a third plat the trees were planted directly in sod and the ground kept cultivated around each tree over a circular area of 3 or 4 feet in diameter. The grass between the trees was cut and allowed to lie where it fell. On a fourth plat the trees were also set in sod, but instead of cultivating the area around each tree they were heavily mulched with straw, the trunks of the trees being inclosed with fine-mesh wire-screen cylinders to prevent injury from rodents. The grass in this plat was cut three or four times each season, raked up, and used as a mulch about the trees.

The average results of the different methods of orchard culture, covering a period now of six years, is quite markedly in favor of planting in sod and mulching the trees. The trees on the plat thus treated have made a heavier and more vigorous growth than under any other system of culture, and have produced double as much fruit. Under the cultivation and cover-crop method of culture the trees made very nearly as good a growth, and the fertility of the soil was kept up. The fact, however, that the general results, as regards both tree growth and yield of fruit, are inferior to the grass-mulch method is the surprising thing.

The poorest results of all were obtained when clean cultivation thruout the season was practised, since no humus or fertility was added to the soil by this method and the ground washt and gullied so badly that heavy fills were necessary, and the practise had to be abandoned at the end of the fourth year.

The trees set in sod and having a circular area cultivated about them gave very good results for the first two or three years, after which much better results were secured by either the cover-crop method or the grass-mulch method. This method of culture was the most expensive and laborious plan adopted. Its chief usefulness is on small, very rough, or stony areas, where mulching material is not available, or on home grounds where neat and sightly grounds are desired.

---

[a] See also U. S. Dept. Agr., Farmers' Bul. 202, p. 11.

A careful study was made of the root systems of the trees grown by the different methods of culture. It has been generally claimed that by the cultivation and cover-crop system of orchard culture the main root system develops to a greater depth in the soil, and that on this account such orchards are less injured by heat, drought, and winter freezing than mulched orchards. It has further been claimed that when trees are grown by the sod-mulch system the entire root system, especially the feeding rootlets of the trees, develop close to the surface of the ground and are thus very easily affected by heat, drought, and cold.

The station investigations do not support these views. It was found that the main root system of the apple trees was formed at a very uniform depth in the soil whatever method of culture was followed, the larger portion of both large and small roots being found in the upper 6 inches of soil. With clean cultivation, followed by cover crops, the fibrous roots were found to reach upward to the very surface of the soil, while only a very small percentage of the rootlets penetrated the lower and more compact colder soil. All of these fibrous roots are pruned away by the plow each succeeding year, apparently without injury to the trees, and are replaced by a new set.

In the grass-mulched area a large mass of fibrous rootlets had developed on the surface of the soil and even in the lower layers of the mulch itself. In addition, however, there was equally as great a development of feeding rootlets in the upper 6 inches of soil as was the case in the cultivated cover-crop area. In the opinion of the investigators it is evident that "the removal of the mulch, or even a change from heavy mulching to the clean-culture cover-crop plan, would not be as disastrous as has been generally supposed."

On the whole, the results up to this time have been very favorable to the grass-mulch system. The work, however, the authors wish to have considered suggestive rather than conclusive. The advantage of the sod-mulch method is that it is equally well adapted to orchards on sloping or steep grounds, where cultivation can not well be performed, or to level lands. It has the advantage of sightliness at all times and permits of general orchard operations like pruning, spraying, gathering the fruit, etc., during rainy weather when the cultivated ground would be soft and muddy.

The better growth of the trees under the sod-mulch system is believed to be "due to the certainty and uniformity of the generous store of fertility right at hand—the concentration of an abundance of plant food where it is most available, and the consequent presentation of conditions beneath the mulch of vegetable matter especially favorable to a healthy, unstinted, continuous nourishment of the trees."

## INCREASING THE HARDINESS OF YOUNG FRUIT TREES.[a]

Owing to the tendency of nursery stock and young trees to grow late in the fall there is much greater danger from winter injury than with older trees. It has long been known that if trees enter the winter with well ripened, mature wood they can withstand a much greater degree of cold without injury than when the branches are in a green, sappy condition, due to late growth.

The commonest way of inducing the young trees to stop growth in early fall, so that the wood may become thoroly ripened and mature, is to plant cover crops in the orchard either in late summer or early fall. In the East such cover crops may be planted as will grow thruout the fall and even live over winter. These cover crops utilize in their growth a large amount of soil water up to the time when freezing weather sets in. They thus tend to dry out the soil. This reacts on the trees, checking growth and inducing early ripening of the wood.[b] In some of the prairie States, however, where the winter winds are both cold and dry, it is very desirable that the soil be well filled with moisture when winter sets in, since during the whole of the winter evaporation from the tree is constantly going on, and if the moisture is not in the soil to meet this demand the result is the serious injury, or even death, of the trees.

At the Nebraska Station R. A. Emerson has made an exhaustive study of the value and methods of handling different cover crops to secure hardiness of peach trees 1 to 4 years old.[c] His conclusions may be summarized as follows:

(1) That rapidly growing peach trees of this age are rendered hardier, both in wood and fruit bud, by the use of cover crops that check growth in late summer, but that while cover crops are valuable in lessening winter injury they are not so important as the choice of hardy varieties or the selection of a comparatively high site for the orchard. "In other words, a very tender variety can not be grown here successfully even by resorting to the use of a cover crop, and no variety is as reliable on low ground with a cover crop as on high land without one." But even hardy varieties on high land are made more reliable by means of cover crops.

(2) That the ideal cover crop at the station is one that starts promptly into growth as soon as planted, in order to insure an even stand and to choke out weeds. It should grow vigorously to insure a heavy winter cover and to dry the ground out comparatively early in the fall. It should be such as will be killed by early frosts, so that it will stop drying the ground after danger of late tree growth is past,

[a] Compiled from Nebraska Sta. Bul. 92; North Dakota Sta. Bul. 49.

[b] See also U. S. Dept. Agr., Farmers' Bul. 87, p. 12.

[c] See also U. S. Dept. Agr., Farmers' Bul. 202, p. 148.

and thus permit of the retention of all the rains of fall in the soil for winter use. "The cover crop should be heavy enough to furnish as good direct protection as possible against the freezing and thawing of the ground, and it should stand sufficiently erect to hold snow against the power of strong winds." A winter covering of snow is very effective as a means of protection from deep freezing of the ground and from alternate freezing and thawing. On the rich soil of the station the best cover crops, all things considered, are corn, cane, and millet.

Corn makes a poorer growth during a dry fall than cane or millet. When sown rather late, not more than two months before the first frost, corn and cane are apt to break down and lie too flat upon the ground to hold snow well. When sown earlier they stand up somewhat better, but are rather heavy and coarse to work into the ground well the next spring. Millet makes a good cover if it can get six weeks of growth before frost. It stands nearly erect, and thus holds the snow well, and is so leafy that it affords fair winter protection even without snow. * * * The main drawback to millet is the fact that when the early frosts are delayed much more than two months after it is sown it ripens seed so abundantly as to be a nuisance the next season. When sown between the middle and last of July it has ripened seed twice during the past six years. The large German millet is to be preferred to the smaller kinds, and is the sort used in the tests at the experiment station. A crop that would behave like millet in all other respects but ripen later would be as near the ideal cover crop as we could expect to find.

While cover crops have been found decidedly beneficial in Nebraska, C. B. Waldron, at the North Dakota Station, found them decidedly harmful in that State, owing to the light autumn rainfall and the very drying winds of winter. He advises, therefore, for that State cultivation in the orchard from the beginning to the end of the season. Professor Waldron's comments on this matter are as follows:

There is occasionally something said about stopping cultivation in August, so that the plants may have opportunity to ripen up their wood for winter. There may be regions where this is good advice, but our experience and observation have led us to just the opposite conclusion and practise for the Northwest. When winter once begins to settle down upon the land in North Dakota even the trees have sense enough to detect it, and the suddenness and completeness with which they close up their summer affairs and get into winter attire suggests that they need no aid from us in the matter. Indeed, some of the plants that defer this change the longest, like the buffalo berry and lilac, are among the hardiest we have.

To preserve moisture and to prevent winter root killing as winter comes on he states that—

Unless covered with snow the ground soon becomes very dry and cracks open, allowing the roots to dry out and subjecting them also to an unusual and unnecessary degree of cold. By covering the ground with a light layer of straw or similar material about the first of November this condition is avoided. This covering prevents the escape of moisture, as the drying winds can not come in contact with the soil, and also the escape of heat, thus delaying freezing for a considerable time and shortening the period in which the plant is losing moisture without means of renewing its supply. Theoretically, then, the application of a mulch would seem to be an advantage, and in actual practise it has been found to be of the greatest importance, saving whole plantations in regions where unprotected trees were practically all killed.

## PROTECTING COWS FROM FLIES.[a]

Every dairyman has observed the annoyance to which cows are subjected by the attacks of flies, and the opinion generally prevails that the fly nuisance is not only a source of annoyance but causes a loss of weight and a diminution of the milk yield.[b] The extent of the loss caused by attacks of flies naturally depends upon the kind of flies and their numbers. The horn fly is most injurious, and has become distributed thruout the United States and Canada wherever dairying is carried on.

At the Kansas Station it was found desirable during the worst part of the fly season to keep the cows in cool barns during the daytime, with screen doors and windows, and allow grazing on the pasture only at night. In many cases, however, this arrangement is not possible, and some fly repellant must be used. For this purpose the best results were obtained from the use of a mixture containing 1½ pounds of resin, 2 cakes of laundry soap, a half pint of fish oil, and enough water to make 3 gallons. The mixture is to be applied with a brush, or, if used as a spray, a half pint of kerosene may be added before using. The cost of the mixture is 7 or 8 cents per gallon, and one-half pint is considered enough for a single application to each cow. It was found that at first two or three applications per week were necessary, but later treatment need not be given so often, since the tips of the hair become coated with resin.

In Missouri a proprietary fly repellant was tested on a herd of cows for alternate periods of two weeks. A careful record was kept of the amount of milk and butter fat obtained during the alternate periods, and from a summary of these records it appears that when the fly repellant was applied every morning the cows were well protected, but that the remedy was not effective unless applied every day. At the Missouri Station the amount of milk obtained when the cows were treated was less and the amount of fat greater than when no treatment was given. The yield of milk and fat, however, was apparently not appreciably affected by the use of the fly repellant. The chief advantage noted in the use of the preparation was that the cows stood more quietly during milking.

According to the observations made at the Virginia Station, horn flies are of so much annoyance that beef cattle decrease in weight slowly and milch cows fall off in their yields from one-fourth to one-half during the horn-fly season. A test of various proprietary remedies gave very unsatisfactory results, and resort was finally had to the use of kerosene emulsion applied as a spray in a specially constructed shed, where the movement of the animals could be regulated and where drafts could be prevented. For this purpose kerosene emul-

[a] Compiled from Kansas Sta. Bul. 125; Missouri Sta. Bul. 68; Virginia Sta. Bul. 153.
[b] See also U. S. Dept. Agr., Farmers' Bul. 225, p. 19.

sion was prepared according to a formula calling for one-half pound of yellow soap, 1 gallon of soft water, and 2 gallons of kerosene oil. The mixture after preparation was diluted again with 1 gallon of water. This stock solution was diluted just before using by adding 1 part to 5 parts of water. An ordinary spray pump was used, and piping was so constructed and fitted with nozzles as to throw the spray upon the animal from all directions, but particularly on those parts which the horn fly most frequents. Very gratifying results were obtained from the use of this method, "daily spraying for two weeks having reduced hordes of horn flies to a point of insignificance." The flies are killed during the passage of the animal thru the spray. It was found that 15 gallons of the diluted solution was sufficient to treat 100 cattle.

## EFFECT OF SILAGE ON THE FLAVOR OR ODOR OF MILK.[a]

The use of corn silage in milk production has become well established. Experimental results and practical experience have alike been favorable to the economy of this method of utilizing crops where dairy farming is conducted on a scale at all extensive. From time to time, however, objections have been raised to the use of silage, on the ground that it imparts an unpleasant or disagreeable flavor to the milk. Considerable has been written on this particular subject, including several articles in recent experiment-station publications, which it is the purpose of this note to summarize briefly.

Milk from cows fed on corn silage at the Oregon Station, as reported by A. L. Knisely, had a more pronounced odor than milk from cows fed hay, altho the odor was considered not at all disagreeable.

In recent experiments with soy-bean silage at the Wisconsin Station, F. W. Woll and G. C. Humphrey found that this material had a very bad effect upon the quality of the milk, butter, and cheese produced, and concluded as a result of their experience that satisfactory dairy products can not be made when cows are fed this silage.

In earlier work with corn silage at the same station by F. H. King "it was demonstrated beyond question that when silage is fed a short time before milking a sweetish odor is imparted to milk, by which it may be detected from milk not produced from silage. It was further demonstrated that if the silage is fed to cows just after milking, in the majority of cases milks so produced could not be separated by the sense of smell from nonsilage milks." Butter made from such milk, while still possessing the sweetish silage odor, was scored by experts higher for flavor than other butter.

In continuing this line of work two or three years later F. H. King and E. H. Farrington divided a quantity of sweet milk into two portions, one of which, contained in an open pail, was placed upon the

[a] Compiled from Illinois Sta. Bul. 101; Oregon Sta. Rpt. 1903, p. 44; Wisconsin Sta. Bul. 59, p. 25, Rpt. 1904, p. 67.

silage inside a silo for one hour. Both portions were then examined by experienced judges to see if they could detect the silage odor in the milk. Out of 120 such examinations the results were correct in 107 cases and wrong in 13. Again, two portions of the same milk were taken to the silo, one being exposed within the silo for one hour and the other having the air of the silo forced thru it for the same length of time. In 7 out of the 24 examinations made the milk was pronounced as having no silage odor. The experts agreed that the odor taken up by milk when exposed to silage was much less pronounced than that found in milk produced by cows fed silage just before milking. It appeared, therefore, that the odor of silage enters the milk more readily thru the cow than from the air.

Recently W. J. Fraser, of the Illinois Station, has published some observations on the same subject. The dairy herd was divided into two lots, one of which was fed 40 pounds of corn silage per cow daily, while the other lot was fed only clover hay and grain. The milk from each lot was standardized to 4 per cent and otherwise cared for in exactly the same manner. Samples from each lot, during the course of the experiments, were submitted to 372 persons for an opinion as to any difference in the flavor of the two samples, anything objectionable about either, and any preference. The results showed that 60 per cent preferred silage milk, 29 per cent nonsilage milk, and 11 per cent had no choice. When the silage was fed at the time of milking, the percentage in favor of silage milk was much higher than when the silage was fed one hour before milking or after milking. Five samples of each lot were sent to milk experts in different cities, three of whom preferred silage milk, one nonsilage, and one had no choice. No complaint was received from a hotel to which silage milk was delivered for a period of one month. On the whole, it was apparent that the greater number of people were able to distinguish between the two kinds of milk, but found nothing objectionable about either kind.

This is strong evidence that if the silage is of good quality and used in reasonable amounts, in connection with other feed, it is one of the best feeds obtainable for dairy cows when pasture is not available. It must be remembered that in all of this work nothing but good silage was fed and no spoiled silage was allowed to accumulate in or around the silo. When silage imparts a bad or disagreeable flavor to the milk produced from it, almost invariably the cause is that the silage has not been fed properly, or that spoiled silage has been used.

It should not be understood from this discussion that the time of day a food is fed which may impart a bad flavor to the milk is of no consequence. All feeds of this nature should be fed after milking and not before, to avoid the possibility of producing an unpleasant flavor in the milk.

It may be concluded that these more recent results are in accord with the statement made by C. S. Plumb, in Farmers' Bulletin 32, that "it is now generally recognized that, with the improved modern methods of using silage and with proper precautions to prevent the

milk after it has been drawn from the cow from being tainted with the objectionable odor of badly fermented silage, the material may be freely used without danger of injury to the quality of dairy products."

## COLD STORAGE OF CHEESE.[a]

In an earlier number of this series[b] experimental work relating to the curing of cheese in cold storage was briefly reviewed. It is the purpose of the present note to supplement that article by brief reference to the results of experiments recently reported in two bulletins of the Bureau of Animal Industry of this Department. When the earlier article was written the storing or curing of cheese at refrigerator temperatures was in an experimental stage. It is now almost the general practise in this country to put cheese into cold storage before it is cured.

In the first series of experiments in the bulletins referred to, the advantage of cold storage in lessening the loss in weight of cheese is well illustrated. About 3 tons of cheese, representing the types or sizes known as Cheddars, Flats, and Young Americas, was divided as evenly as possible into 3 lots and stored at temperatures of 28°, 34°, and 40° F. The Cheddars weighed on an average 68 pounds, the Flats 37.7 pounds, and the Young Americas 10.4 pounds.

When stored at 40° the Cheddars lost 5.87 per cent in weight during 247 days, the Flats 5.53 per cent during the same period, and the Young Americas 9.34 per cent during 233 days. When stored at 34° for the same periods the Cheddars lost 5.12 per cent, the Flats 4.37 per cent, and the Young Americas 6.95 per cent. When stored at 28° under the same conditions the losses were as follows: Cheddars, 2.88 per cent; Flats, 2.19 per cent; and Young Americas, 4.25 per cent. Assuming that the cheese sold at a uniform price of 10 cents a pound, storing at 28° as compared with storing at 40° resulted in a saving of 30 cents per hundredweight for Cheddars, 33 cents for Flats, and 51 cents for Young Americas. Paraffining the cheese reduced the loss in weight still more. The quality of the cheese was not influenced to any marked extent by the different temperatures used.

In the more recent experiments planned and conducted by C. F. Doane storage temperatures of 32° and 40° F. were selected as covering the range of temperatures actually employed in different establishments where cheese is stored under commercial conditions at the present time. The cheese used was manufactured under ordinary factory conditions and placed in cold storage directly from the press and at the age of one and two weeks. The time of putting cheese into storage was found to vary considerably in practise, and it was therefore one of the principal objects of the experiments to gain information on this point. Only one style of cheese—the Daisy—was

[a] Compiled from U. S. Dept. Agr., Bureau of Animal Industry Buls. 83 and 85.
[b] U. S. Dept. Agr., Farmers' Bul. 186, p. 30.

chosen, as it was believed that the size of the cheese has very little influence on its quality. For part of the cheese rennet was used at the usual rate of 3 ounces per 1,000 pounds of milk and for the remainder at double this rate. The cheese put into cold storage at the end of one and two weeks was paraffined before storing, while that placed in storage directly from the press was not paraffined until it was three to five weeks old in deference to the popular belief among dealers that cheese direct from the press can not be paraffined without injury to quality.

Here again the results show that cold storage lessens materially the loss in weight of cheese. The saving by paraffining and storing cheese at the end of one week rather than at the end of two weeks amounted to 4 ounces per cheese in the 32° room and 5 ounces per cheese in the 40° room, the average weight of the cheese being about 19 pounds. In many cases there was no loss in weight whatever from the time of paraffining to the time of final weighing—five to seven months later.

The average total scores of the cheese are shown in the following table:

*Scores of cheese in cold-storage experiments.*

| Kind of cheese. | Stored from press. | | Stored at 1 week. | | Stored at 2 weeks. | |
|---|---|---|---|---|---|---|
| | At 32°. | At 40°. | At 32°. | At 40°. | At 32°. | At 40°. |
| | *Pounds.* | *Pounds.* | *Pounds.* | *Pounds.* | *Pounds.* | *Pounds.* |
| Low rennet | 95.0 | 94.3 | 93.8 | 90.0 | 93.0 | 90.0 |
| High rennet | 94.4 | 92.3 | 93.4 | 90.3 | 91.6 | 90.9 |

In some instances taints developed in the cheeses which were not put in cold storage until after one and two weeks, but did not appear in the cheeses placed in cold storage directly from the press. Furthermore, when taints had once started to develop the temperature of 32° served much better to hold them in check than the temperature of 40°. Doane therefore believes that the greatest beneficial influence of cold curing is with what would otherwise be poor cheese.

Some interesting results were obtained with lots of cheese which had been allowed to develop too much acid in the process of making. Such cheese held in the factory for two weeks and then placed in storage at 40° was much deteriorated, while that placed directly in storage at 32° was pronounced very good. Contrary to the belief generally held by dealers, the results therefore indicate that cheese with too much acid should be placed in cold storage as quickly as possible, and the colder the room the better. The results of these experiments are therefore favorable to the putting of cheese into cold storage at an earlier age even than the one to two weeks now customary and show that this method is valuable in preventing taints and the bad effects usually following the development of excessive acid. Still further work along this line is being conducted by the Department.



O